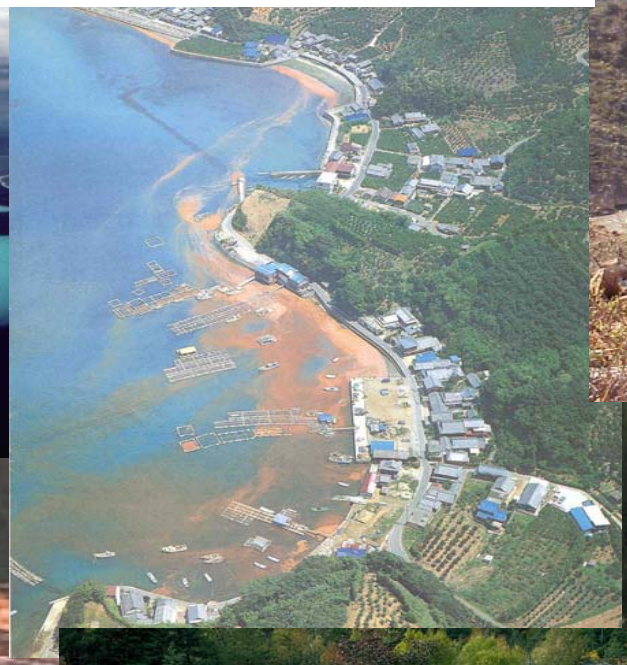
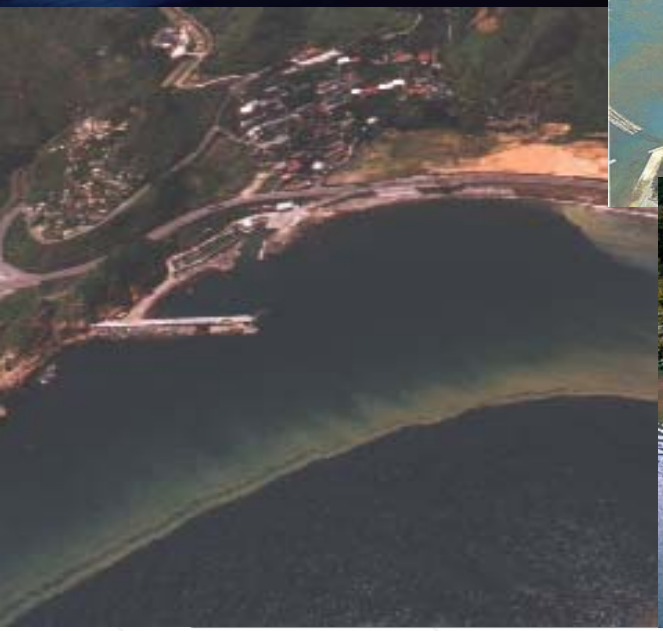
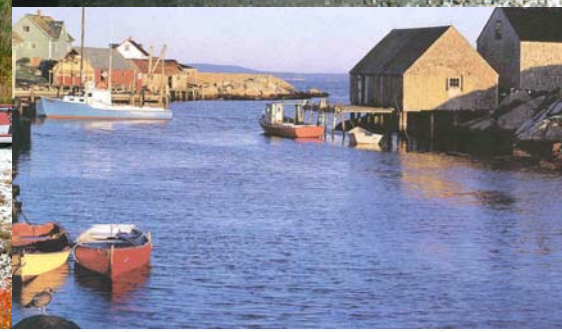
Chemical Ecology of Toxic Algae

Bernd Krock, Urban Tillmann, Uwe John, Sára Beszteri, Chishimba M. Kantu, Allan D. Cembella

Toxic Algal Blooms

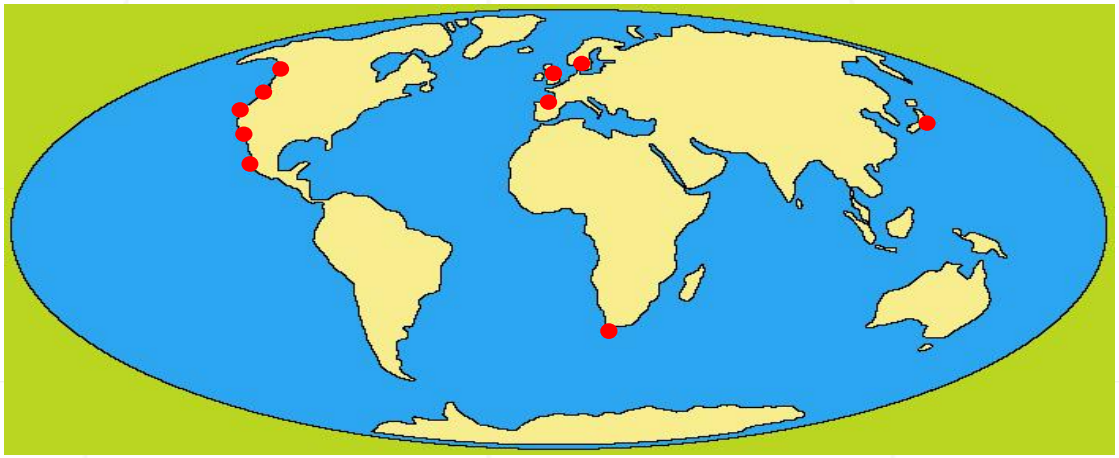



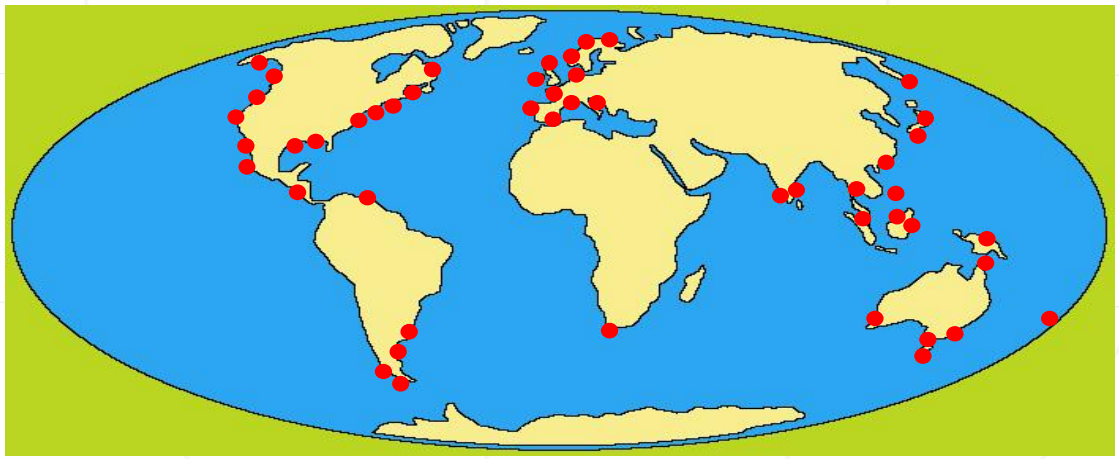


Distribution of Paralytic Shellfish Poisoning events

1970



2005



Lytic Effect of *Alexandrium*

Oxyrrhis marina

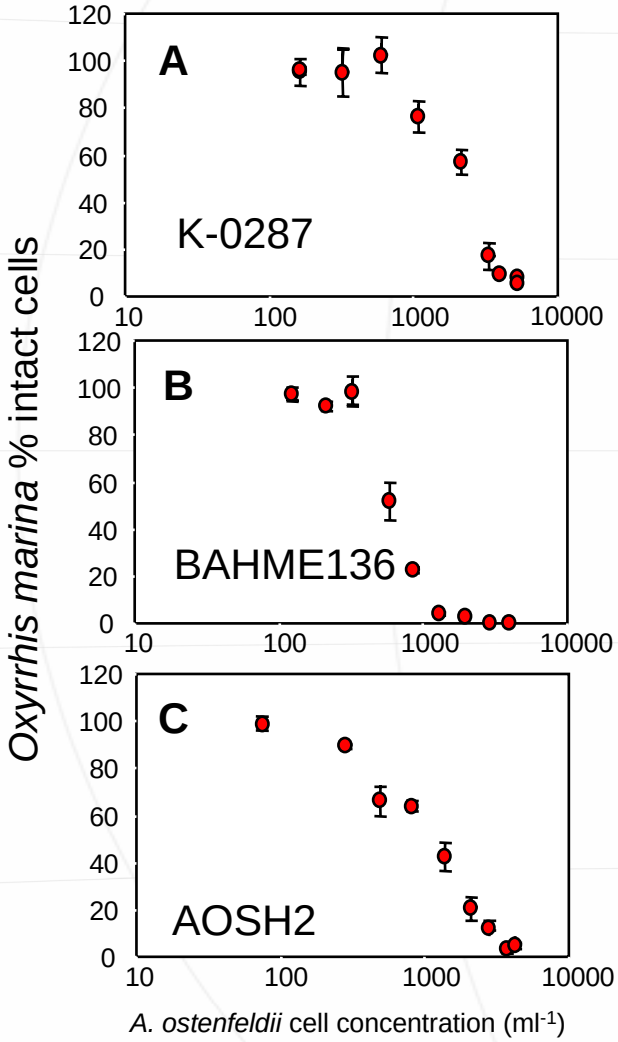
Alexandrium tamarense

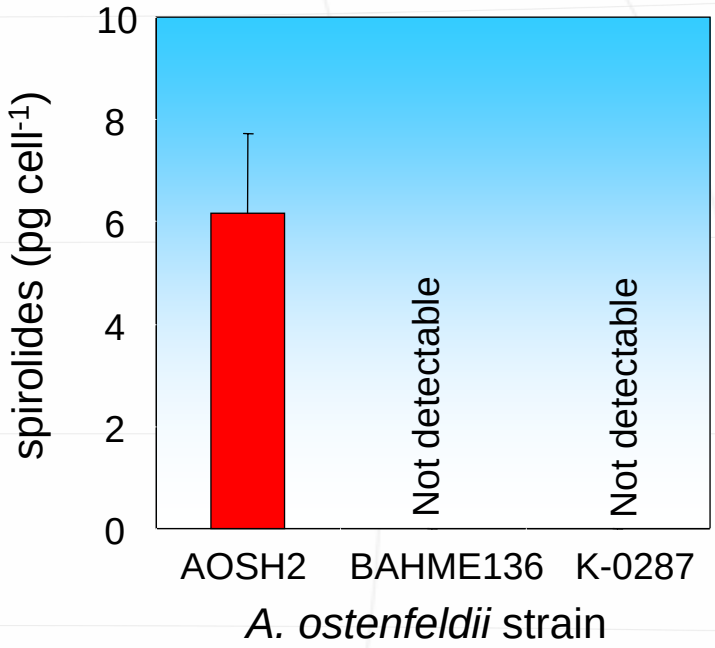
Photos: U. Tillmann

Lytic Effect of *Alexandrium* shown with *Oxyrrhis marina*.

Black arrows: *Alexandrium*
Red arrows: Remainders of *Oxyrrhis*

Lytic Effect of *A. ostenfeldii*





Allelochemical potency is not related to spirolide production

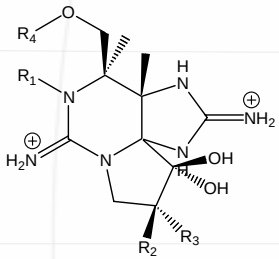
Organism Chemical Interaction Ecological Function

Alexandrium tamarense

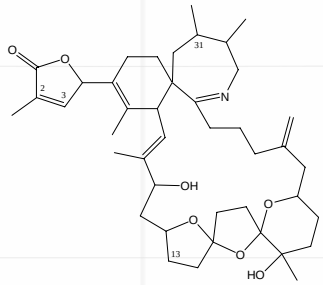
Alexandrium minutum

Alexandrium ostenfeldii

PSP-Toxins



Spirolides



?

Alexandrium tamarense

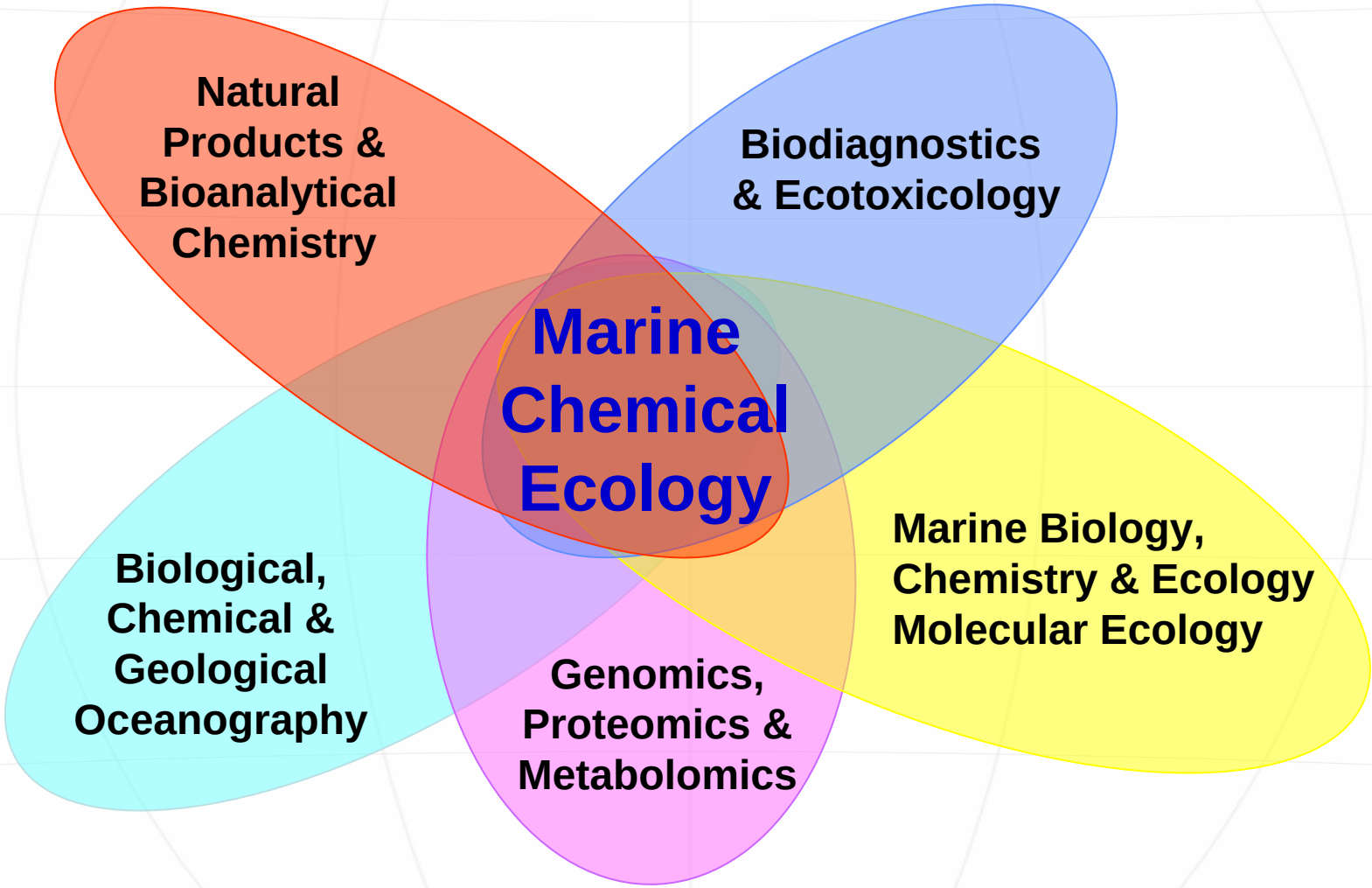
Prymnesium parvum

?

Defense against Predators,

Elimination of Competitors

Towards Inter-disciplinary Science



Strategies to answer these questions:

Can toxic strains be detectected genetically?

=> Genomic characterization (microsatellites, AFLP, rDNA sequence analysis)

Which genes are responsable for growth and toxicity?

=> Gene expession analysis (EST, Data bases, microarrays)

What toxins are present?

=> Bioanalytics (LC-FD, LC-MS/MS)

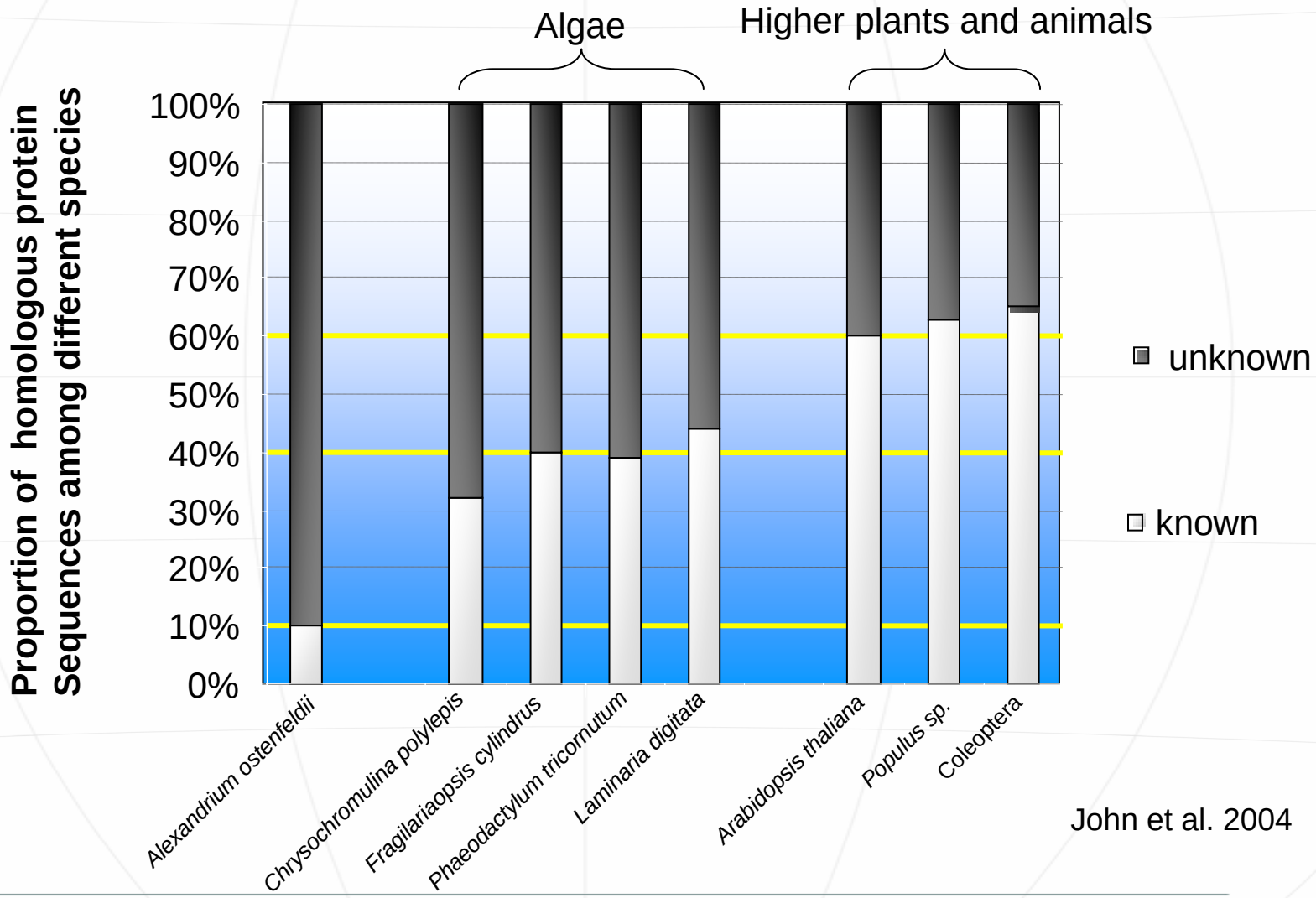
What are the allelochemicals?

=> Chemical experiments & bioassays

What effects do toxins have?

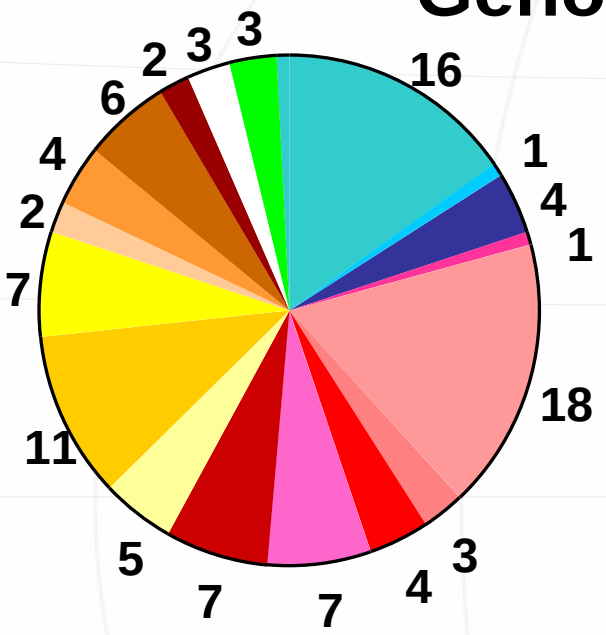
=> Toxicological assays

Genomic Characterization



John et al. 2004

Genomic Characterization



Cell structure

Information storing and processing

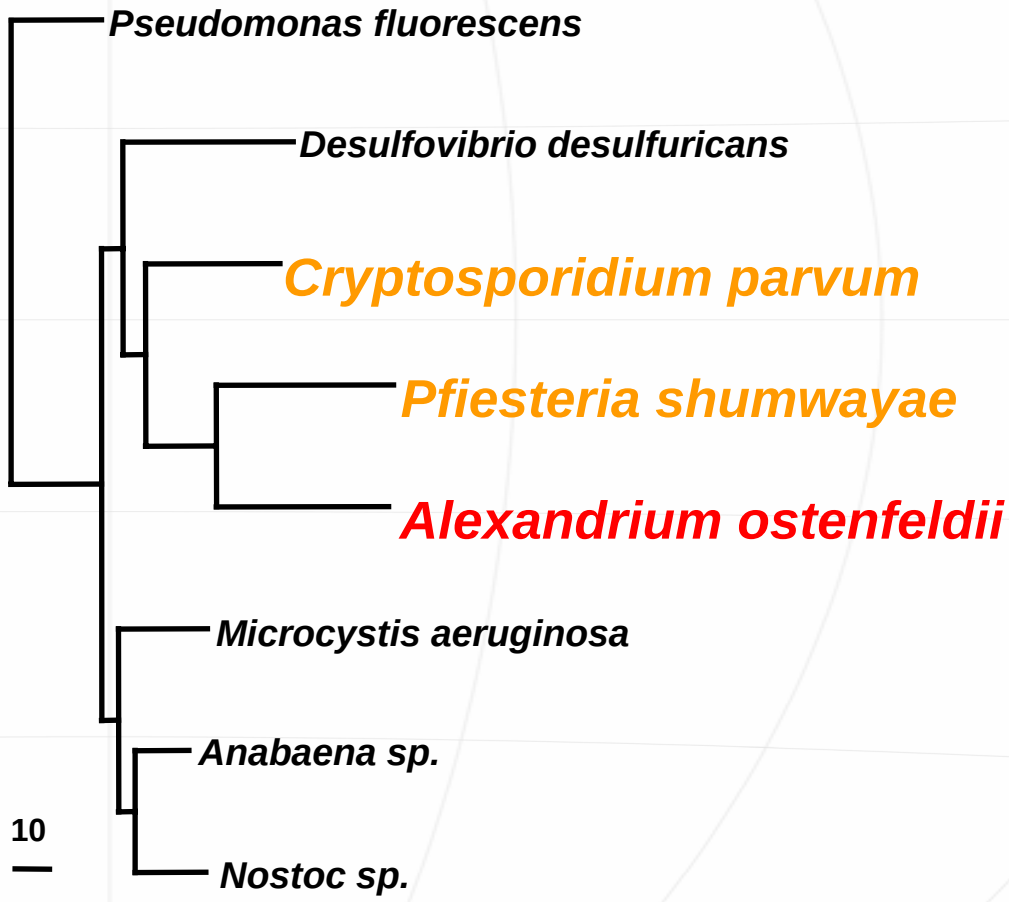
Cellular processes

Metabolism

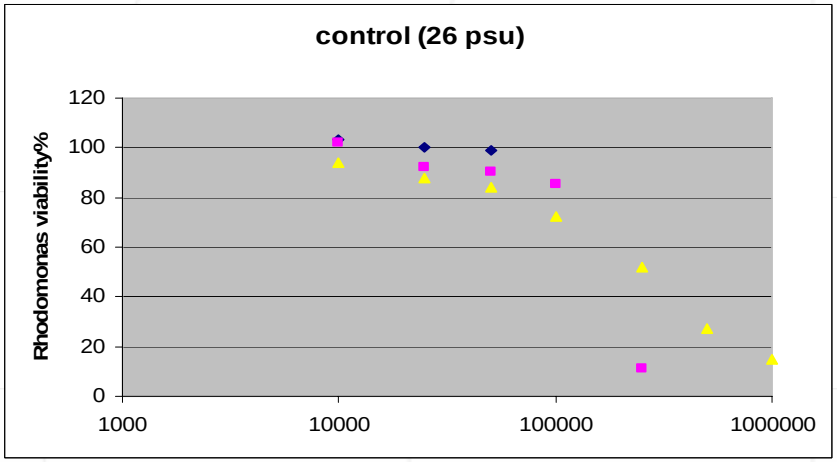
General function (prediction only)

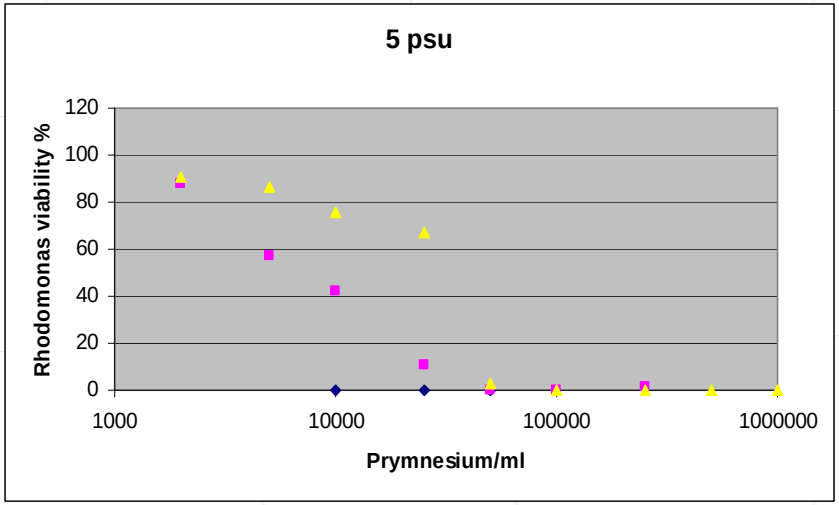
Stress, defence and toxicity

PKS EST Analysis



Gene Expression Analysis



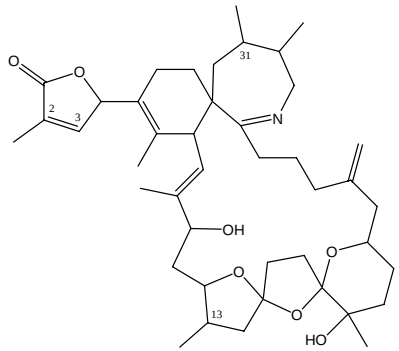


- Early exponential growth phase
- Late exponential growth phase
- Stationary phase

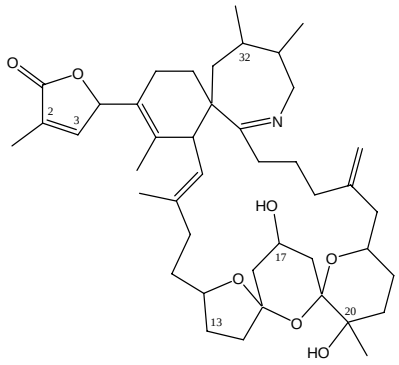
Toxicity of *Prymnesium parvum* is high at low salinity

=> ESTs, Microarrays

Bioanalytics



Spirolide C



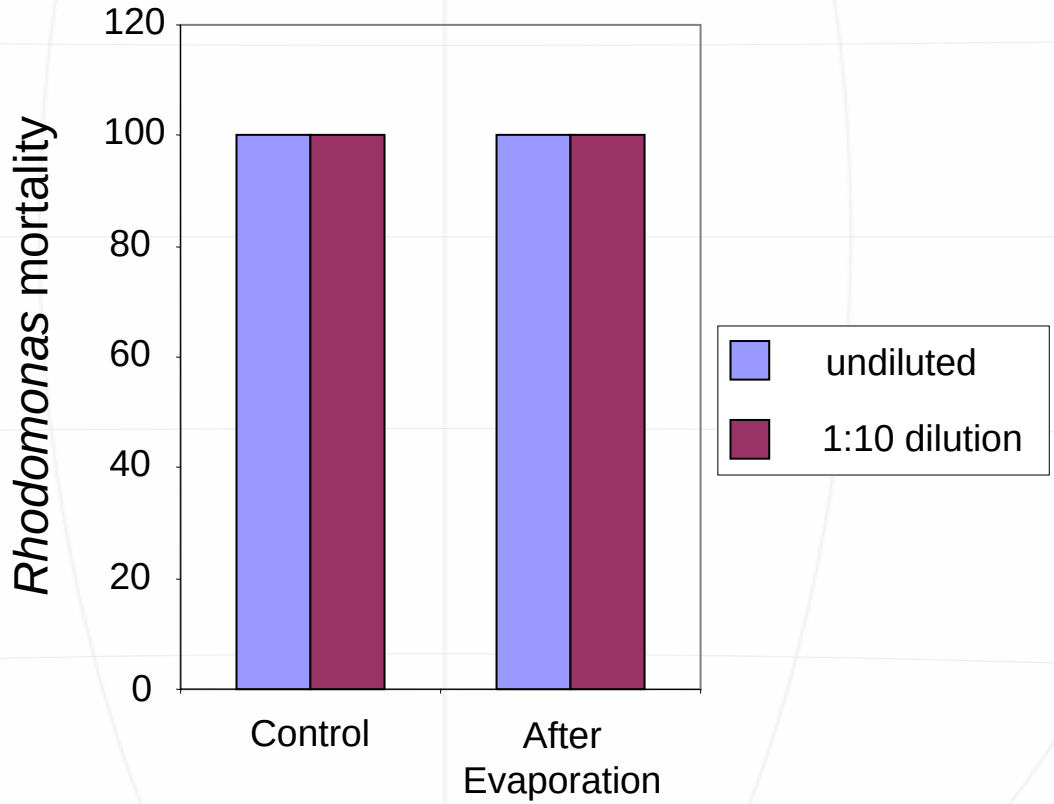
20-Me Spirolide G

604.5 > 356.3
640.5 > 164.1
650.5 > 164.1
692.5 > 150.1
692.5 > 164.1
694.5 > 164.1
706.5 > 164.1
708.5 > 164.1
720.5 > 164.1

Alexandrium ostenfeldii
strain AOSH2

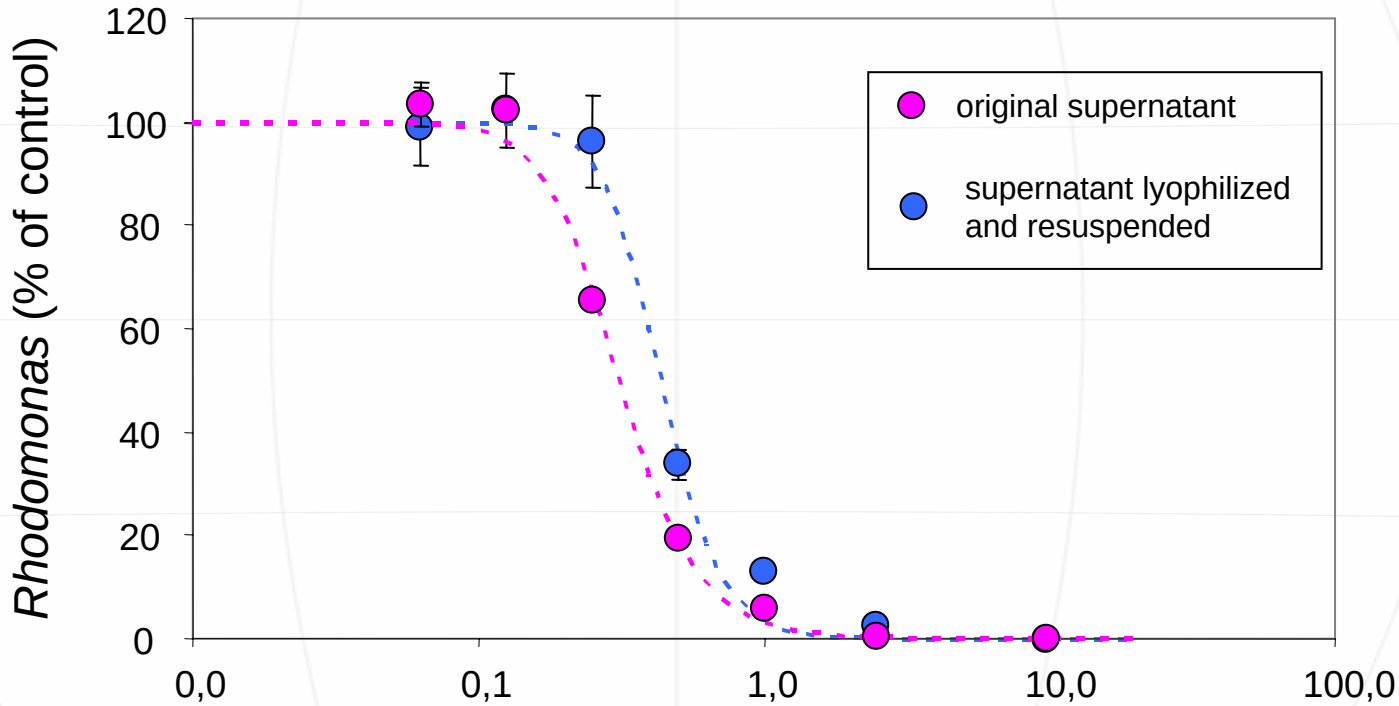
Chemical Exeriments – Evaporation

Alexandrium tamarense supernatant – Lytic Effect on *Rhodomonas*



Chemical Exeriments – Lyophilization

Alexandrium tamarense supernatant – Lytic Effect on *Rhodomonas*

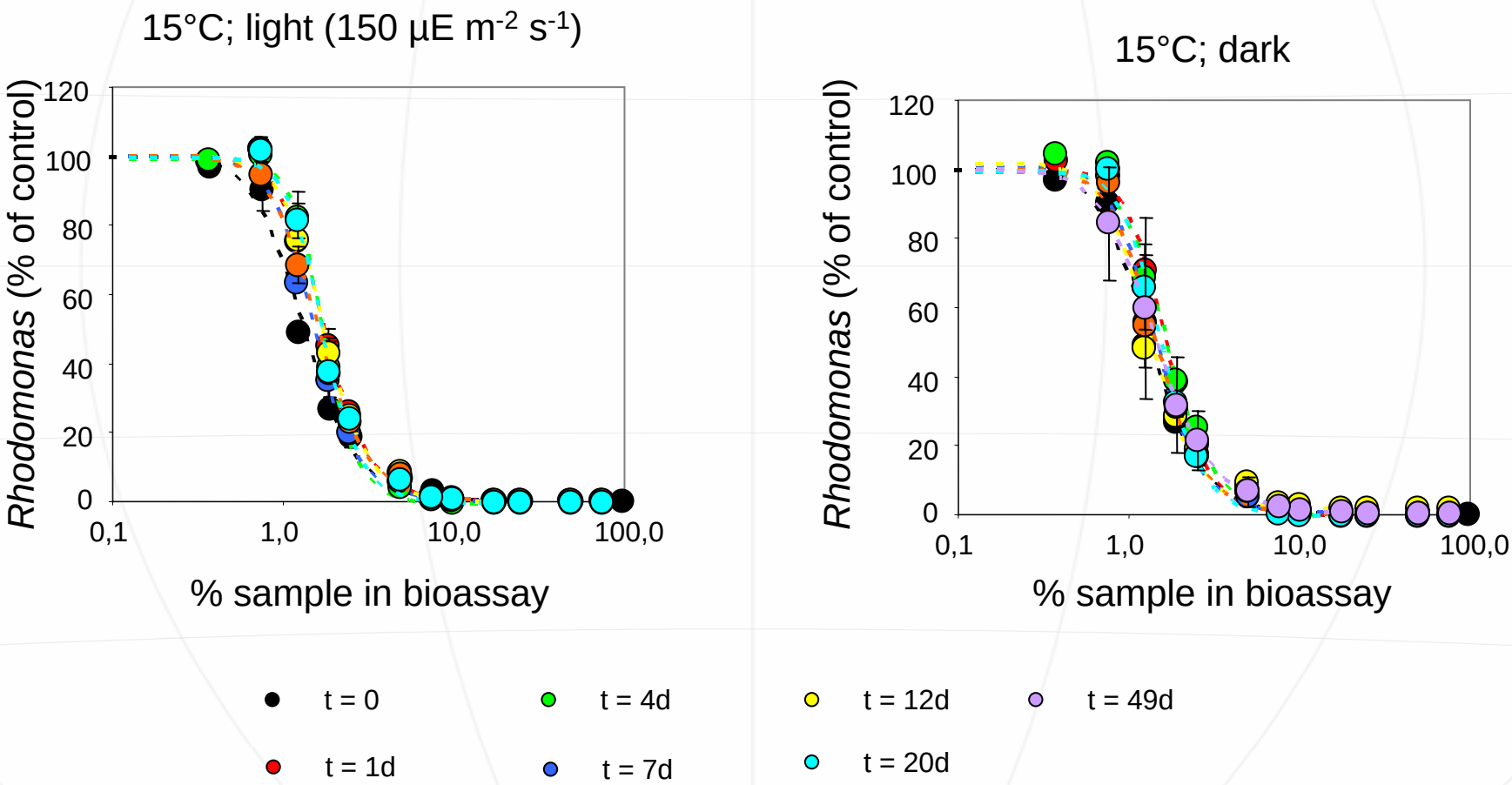


EC_{50} original: 0.31 %

EC_{50} „instant“: 0.44 %

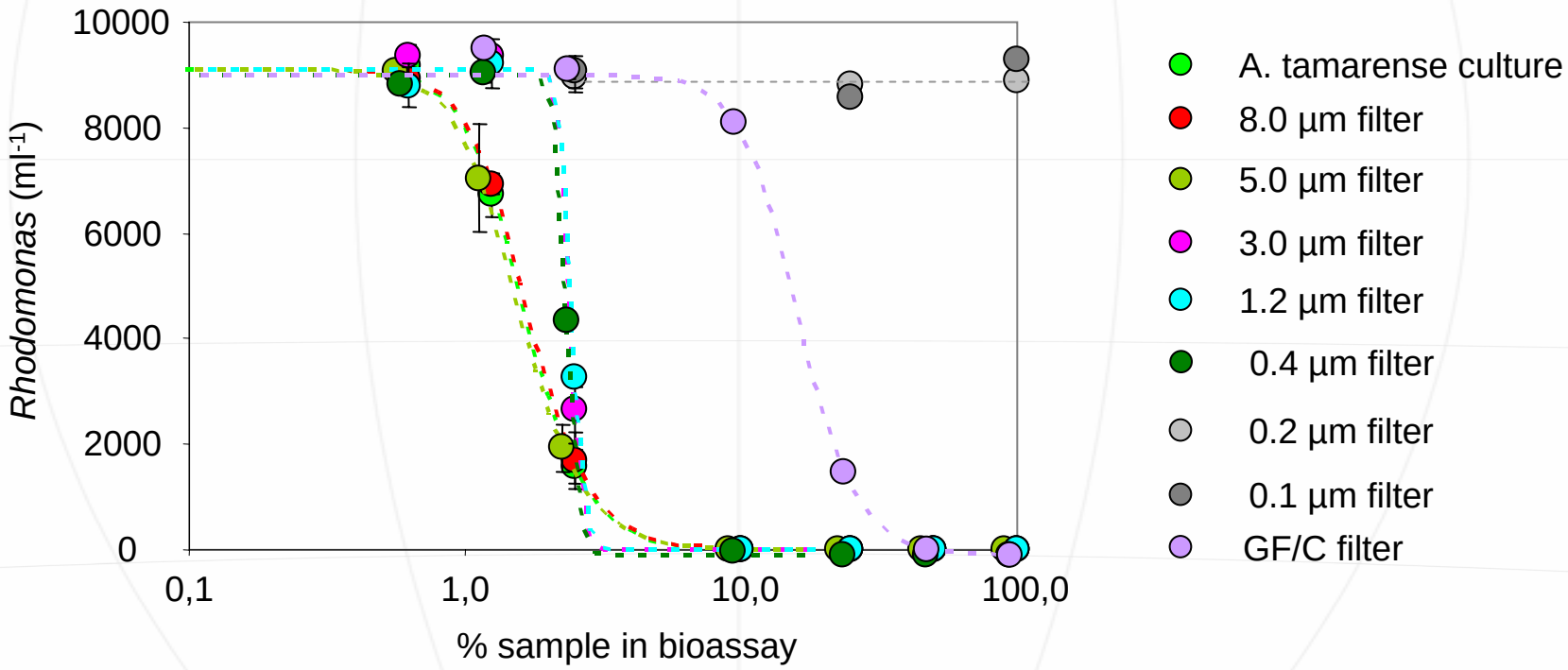
Chemical Exeriments – Stability

Alexandrium tamarense supernatant – Lytic Effect on *Rhodomonas*



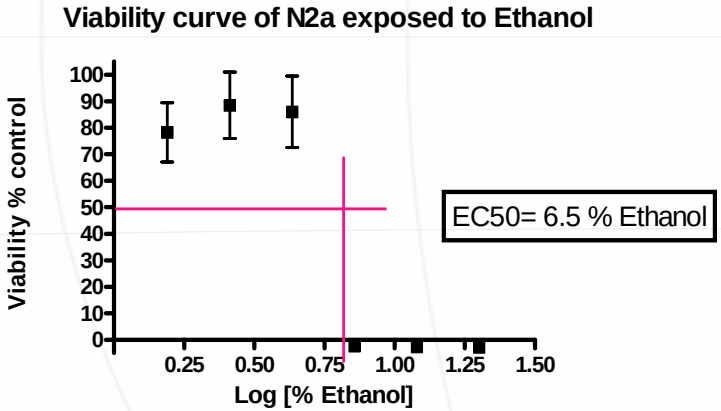
Chemical Exeriments – Filterability

Alexandrium tamarense supernatant – Lytic Effect on *Rhodomonas*

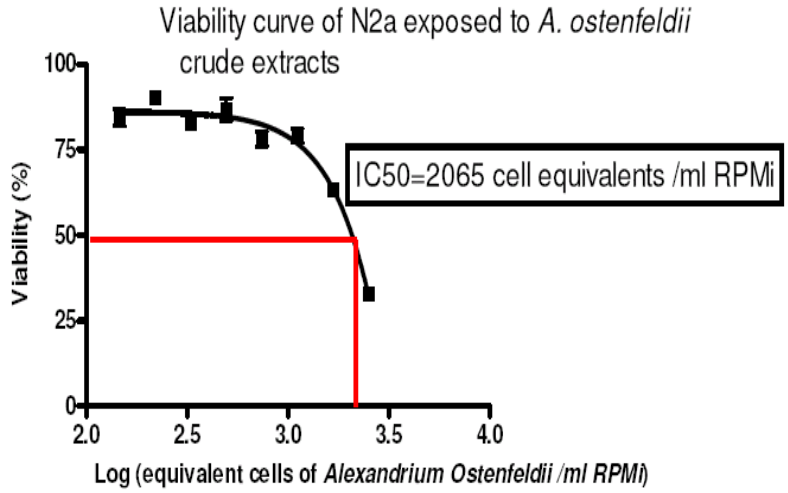


Toxicological assays

Alexandrium ostenfeldii extract – Toxic Effect on Neoblastoma cells



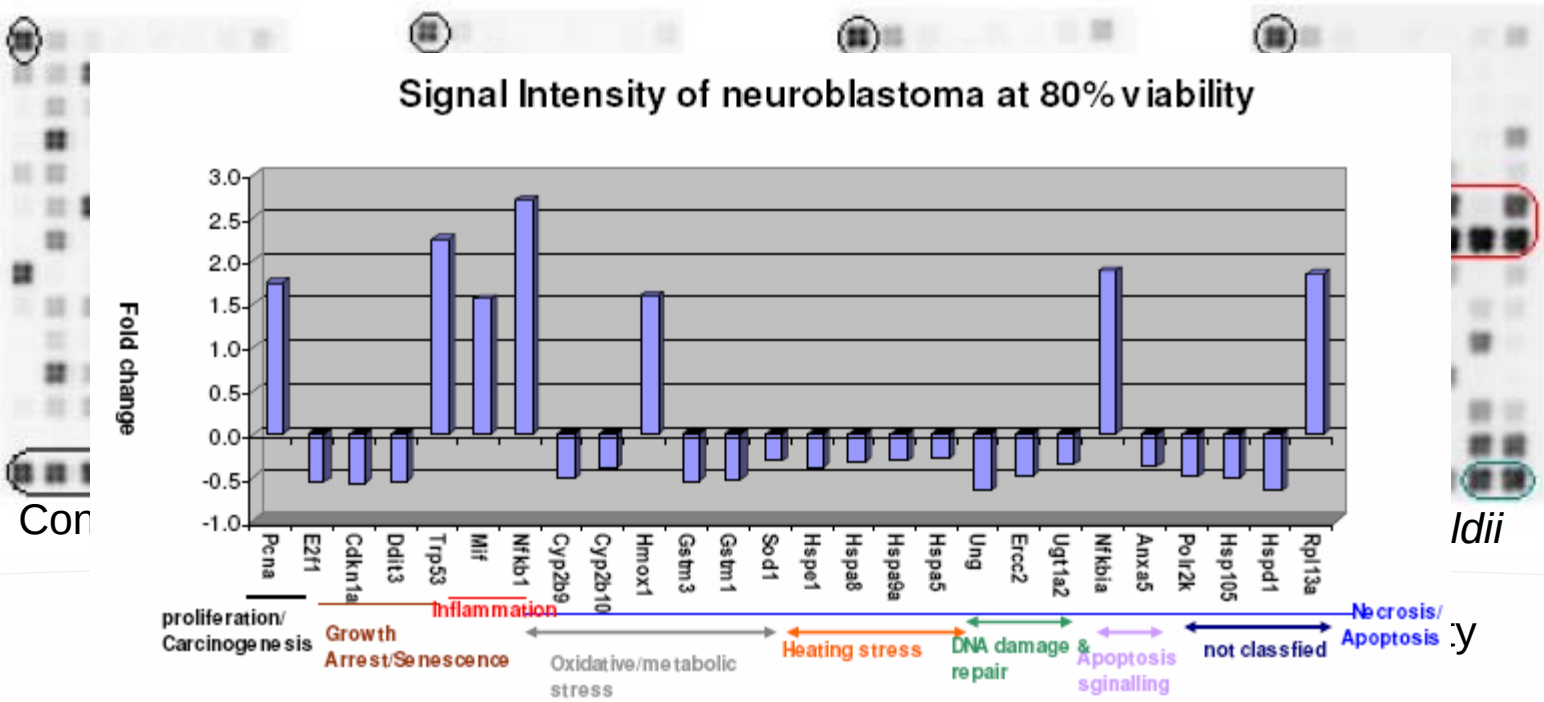
Control



A. ostenfeldii cell extracts

Toxicological assays

Alexandrium ostenfeldii extract – Expression of stress and toxicity related genes (GEArray Q Series Mouse Stress & Toxicity Pathway Finder)



AWI

Allan D. Cembella
Uwe John
Urban Tillmann
Bernd Krock
Tilman Alpermann
Sascha Klöpper
Ines Jung

Sára Beszteri
Nina Jaeckisch
Ines Marschallek
Chishimba M. Kantu
Chibo Chikwililwa
Annegret Müller
Wolfgang Drebing

GKSS

Andreas Prange
Jürgen Gandraß
Sandra Schäfer
Beritt Schwalger

Thank You

for

Your Attention!